CALIFORNIA HIGH-SPEED TRAIN

Program Environmental Impact Report/Environmental Impact Statement

LOS ANGELES to SAN DIEGO VIA THE INLAND EMPIRE

PALEONTOLOGIC RESOURCES TECHNICAL EVALUATION

January 2004

Prepared for:

California High-Speed Rail Authority

U.S. Department of Transportation
Federal Railroad Administration

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CALIFORNIA HIGH-SPEED TRAIN PROGRAM EIR/EIS

Los Angeles to San Diego via the Inland Empire
Paleontologic Resources Technical Evaluation

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ACRONYMS

APE	AREA OF POTENTIAL EFFECT
AUTHORITY	CALIFORNIA HIGH-SPEED RAIL AUTHORITY
CEQA	CALIFORNIA ENVIRONMENTAL QUALITY ACT
EIR	ENVIRONMENTAL IMPACT REPORT
EIS	ENVIRONMENTAL IMPACT STATEMENT
EPA	ENVIRONMENTAL PROTECTION AGENCY
FAA	FEDERAL AVIATION ADMINISTRATION
FHWA	FEDERAL HIGHWAY ADMINISTRATION
FRA	FEDERAL RAILROAD ADMINISTRATION
FTA	FEDERAL TRANSIT ADMINISTRATION
LACM	NATURAL HISTORY MUSEUM OF LOS ANGELES COUNTY (LOCALITY PREFIX)
NEPA	NATIONAL ENVIRONMENTAL POLICY ACT
NHMLAC	NATURAL HISTORY MUSEUM OF LOS ANGELES COUNTY
NRHP	NATIONAL REGISTER OF HISTORIC PLACES
RPLI	REGIONAL PALEONTOLOGIC LOCALITY INVENTORY, SBCM
RTP	REGIONAL TRANSPORTATION PLAN
SHPO	STATE HISTORIC PRESERVATION OFFICER
SBCM	SAN BERNARDINO COUNTY MUSEUM
SDNHM	SAN DIEGO NATURAL HISTORY MUSEUM
SVP	SOCIETY OF VERTEBRATE PALEONTOLOGY
YBP	YEARS BEFORE PRESENT

1.0 INTRODUCTION

The California High-Speed Rail Authority (Authority) was created by the Legislature in 1996 to develop a plan for the construction, operation, and financing of a statewide, intercity high-speed passenger train system.[1] After completing a number of initial studies over the past six years to assess the feasibility of a high-speed train system in California and to evaluate the potential ridership for a variety of alternative corridors and station areas, the Authority recommended the evaluation of a proposed high-speed train system as the logical next step in the development of California's transportation infrastructure. The Authority does not have responsibility for other intercity transportation systems or facilities, such as expanded highways, or improvements to airports or passenger rail or transit used for intercity trips.

The Authority adopted a *Final Business Plan* in June 2000, which reviewed the economic feasibility of a 1,127-kilometer-long (700-mile-long) high-speed train system. This system would be capable of speeds in excess of 321.8 kilometers per hour (200 miles per hour [mph]) on a dedicated, fully grade-separated track with state-of-the-art safety, signaling, and automated train control systems. The system described would connect and serve the major metropolitan areas of California, extending from Sacramento and the San Francisco Bay Area, through the Central Valley, to Los Angeles and San Diego. The high-speed train system is projected to carry a minimum of 42 million passengers annually (32 million intercity trips and 10 million commuter trips) by the year 2020.

Following the adoption of the Business Plan, the appropriate next step for the Authority to take in the pursuit of a high-speed train system is to satisfy the environmental review process required by federal and state laws which will in turn enable public agencies to select and approve a high speed rail system, define mitigation strategies, obtain necessary approvals, and obtain financial assistance necessary to implement a high speed rail system. For example, the Federal Railroad Administration (FRA) may be requested by the Authority to issue a *Rule of Particular Applicability*, which establishes safety standards for the high-speed train system for speeds over 200 mph, and for the potential shared use of rail corridors.

The Authority is both the project sponsor and the lead agency for purposes of the California Environmental Quality Act (CEQA) requirements. The Authority has determined that a Program Environmental Impact Report (EIR) is the appropriate CEQA document for the project at this conceptual stage of planning and decision-making, which would include selecting a preferred corridor and station locations for future right-of-way preservation and identifying potential phasing options. No permits are being sought for this phase of environmental review. Later stages of project development would include project-specific detailed environmental documents to assess the impacts of the alternative alignments and stations in those segments of the system that are ready for implementation.

The decisions of federal agencies, particularly the Federal Railroad Administration (FRA) related to high-speed train systems, would constitute major federal actions regarding environmental review under the National Environmental Policy Act (NEPA). NEPA requires federal agencies to prepare an Environmental Impact Statement (EIS) if the proposed action has the potential to cause significant environmental impacts. The proposed action in California warrants the preparation of a Tier 1 Program-level EIS under NEPA, due to the nature and scope of the comprehensive high-speed train system proposed by the Authority, the need to narrow the range of alternatives, and the need to protect/preserve right-of-way in the future. FRA is the federal lead agency for the preparation of the Program EIS, and the Federal Highway Administration (FHWA), the U.S. Environmental Protection Agency (EPA), the U.S. Corps of Engineers (USACE), the Federal Aviation Administration (FAA), the U.S. Fish and Wildlife Service (USFWS), and the Federal Transit Administration (FTA) are cooperating federal agencies for the EIS.

[1] Chapter 796 of the Statutes of 1996; SB 1420, Kopp and Costa

A combined Program EIR/EIS is to be prepared under the supervision and direction of the FRA and the Authority in conjunction with the federal cooperating agencies. It is intended that other federal, state, regional, and local agencies will use the Program EIR/EIS in reviewing the proposed program and developing feasible and practicable programmatic mitigation strategies and analysis expectations for the Tier 2 detailed environmental review process which would be expected to follow any approval of a high speed train system.

The statewide high-speed train system has been divided into five regions for study: Bay Area-Merced, Sacramento-Bakersfield, Bakersfield-Los Angeles, Los Angeles-San Diego via the Inland Empire, and Los Angeles-Orange County-San Diego. This Cultural Resources Technical Evaluation for the [name of region] is one of five such reports being prepared for each of the regions on the topic, and it is one of fifteen technical reports for this region. This report will be summarized in the Program EIR/EIS and it will be part of the administrative record supporting the environmental review of alternatives.

1.1 ALTERNATIVES

1.1.1. No-Project Alternative

The No-Project Alternative serves as the baseline for the comparison of Modal and High-Speed Train alternatives. The No-Project Alternative represents the state's transportation system (highway, air, and conventional rail) as it existed in 1999-2000 and as it would be after implementation of programs or projects currently programmed for implementation and projects that are expected to be funded by 2020. The No-Project Alternative addresses the geographic area serving the same intercity travel market as the proposed high-speed train (generally from Sacramento and the San Francisco Bay Area, through the Central Valley, to Los Angeles and San Diego). The No-Project Alternative satisfies the statutory requirements under CEQA and NEPA for an alternative that does not include any new action or project beyond what is already committed.

The No-Project Alternative defines the existing and future statewide intercity transportation system based on programmed and funded (already in funded programs/financially constrained plans) improvements to the intercity transportation system through 2020, according to the following sources of information:

- State Transportation Improvement Program (STIP)
- Regional Transportation Plans (RTPs) for all modes of travel
- Airport plans
- Intercity passenger rail plans (California Rail Plan 2001-2010, Amtrak Five- and Twenty-year Plans)

As with all of the alternatives, the No-Project Alternative will be assessed against the purpose and need topics/objectives for congestion, safety, air pollution, reliability, and travel times.

1.1.2 Modal Alternative

There are currently only three main options for intercity travel between the major urban areas of San Diego, Los Angeles, the Central Valley, San Jose, Oakland/San Francisco, and Sacramento: vehicles on the interstate highway system and state highways, commercial airlines serving airports between San Diego and Sacramento and the Bay Area, and conventional passenger trains (Amtrak) on freight and/or commuter rail tracks. The Modal/System Alternative consists of expansion of highways, airports, and intercity and commuter rail systems serving the markets identified for the High-Speed Train Alternative. The Modal Alternative uses the same inter-city travel demand (not capacity) assumed under the high-end sensitivity analysis completed for the high-speed train ridership in 2020. This same travel demand is assigned to the highways and airports and passenger rail described under the No-Project Alternative, and the additional improvements or expansion of facilities is assumed to meet the demand, regardless of funding potential and without high-speed train service as part of the system.

1.1.3 High Speed Train Alternative

The Authority has defined a statewide high speed train (HST) system capable of speeds in excess of 200 miles per hour (mph) (320 kilometers per hour [km/h]) on dedicated, fully grade-separated tracks, with state-of-the-art safety, signaling, and automated train control systems. State of the art high-speed steel-wheel-on-steel-rail technology is being considered for the system that would serve the major metropolitan centers of California, extending from Sacramento and the San Francisco Bay Area, through the Central Valley, to Los Angeles, the Inland Empire, and San Diego.

The High-Speed Train Alternative includes several corridor and station options. A steel-wheel on steel-rail, electrified train, primarily on exclusive right-of-way with small portions of the route on shared track with other rail is planned. Conventional "non-electric" improvements are also being considered along the existing LOSSAN rail corridor from Los Angeles through Orange County to San Diego. The train track would be either at-grade, in an open trench or tunnel, or on an elevated guideway, depending on terrain and physical constraints.

As described in the introduction, the study area is broadly defined by the Los Angeles to San Diego via Inland Empire corridor segment, which may be broadly divided into three regional segments. Each segment has several alternative alignments for all or a portion of the length of the segment. For example, Segment 1 has three alternative alignments, listed as 1A, 1B, and 1C. Each segment is further subdivided into subsegments for analyzing and reporting potential impacts. The various segment options and subsegments, along with station locations, are described below. A figure illustrating these segments and subsegments is provided in Appendix A.

Regional Segment 1 – Union Station to March Air Reserve Base Segment
Segment 1A
Subsegment 1A1: Union Station to Pomona
Subsegment 1A2: Pomona to Ontario (beginning of Segment 1C)
Subsegment 1A3: Ontario (beginning of Segment 1C) to Colton (end of Segment 1C)
Subsegment 1A4: Colton to March Air Reserve Base (ARB)

Segment 1B
Subsegment 1B1: Union Station to Pomona

Segment 1C
Subsegment 1C1: Ontario (beginning of Segment 1C) to Colton (end of Segment 1C)

Station Locations: El Monte (1A1), Pomona (1A2), Ontario (1A2), Colton (1A3), University of California at Riverside (1A4), South El Monte (1B1), City of Industry (1B1), and San Bernardino (1C1)

Regional Segment 2 – March ARB to Mira Mesa Segment
Segment 2A
Subsegment 2A1: March ARB to Escondido (beginning of Segment 2B)
Subsegment 2A2: Within Escondido (beginning to end of Segment 2B)
Subsegment 2A3: Escondido to Mira Mesa

Segment 2B
Subsegment 2B1: Within Escondido (Beginning to end of Segment 2B)

Station Locations: March ARB (2A1), Temecula (2A2), Escondido (2A2), and Escondido Transit Center(2B1)

Regional Segment 3 – Mira Mesa to San Diego Segment
Segment 3A
Subsegment 3A1: Mira Mesa to Qualcomm Stadium

Segment 3B
Subsegment 3B1: Within Mira Mesa (beginning and end of Segment 3C)
Subsegment 3B2: Mira Mesa (end of Segment 3C) to Downtown San Diego

Segment 3C
Subsegment 3C1: Within Mira Mesa (end of Segment 3C)

Station Locations: Mira Mesa (3A1), Qualcomm Stadium (3A1), Transit Center (3B2), San Diego International Airport (3B2), and Downtown San Diego (3B2)

2.0 BASELINE/AFFECTED ENVIRONMENT

2.1 STUDY AREA (AREA OF POTENTIAL EFFECT) DEFINED

The study area for paleontologic resources is the Area of Potential Effect (APE) that was defined in consultation with the State Historic Preservation Officer (SHPO). At this programmatic Tier 1 level of analysis, the APE is the area within which information about the locations of paleontologic resource localities was obtained from the Regional Paleontologic Locality Inventory (RPLI) at the San Bernardino County Museum (SBCM), as well as from the Department of Vertebrate Paleontology, Natural History Museum of Los Angeles County (NHMLAC).

The APE for this undertaking is defined as 100 feet on each side of the centerline of proposed rail routes, both in non-urban and urban areas. The APE for freeway routes and around airports is defined as 100 feet beyond the existing freeway right-of-way and 100 feet beyond the existing airport property boundary. The reason for using 100 feet for urban rail corridors, freeways, and airports is that very little additional right-of-way would be affected in these areas. The 100 feet on each side of the railroad centerline in non-urban areas may require expansion to 500 feet on each side of the proposed project centerline if subsequent design features indicate that paleontologic resources beyond the presently defined APE might be affected.

Locations of easements and construction-related facilities, such as equipment staging areas, borrow and disposal areas, access roads, and utilities, have not been yet been identified. Locations for these will be identified as part of the construction design program for the alternatives selected for more detailed analysis in the next phase of the project. Thus, these items are not considered in the program level Tier-1 analysis, but this information will be available for Tier-2 site-specific EIR/EIS's. The APE will be modified to include these items as part of the Tier-2 analysis.

2.2 BRIEF GEOLOGIC AND PALEONTOLOGIC BACKGROUND OF REGION

The Los Angeles basin, southwestern San Bernardino County and western Riverside County regions are comprised primarily of surficial Quaternary alluvium, deposited during the Pleistocene and Holocene

Epochs, overlying older rocks of marine, near-shore, or volcanic origin. Of these, the lattermost rocks have low paleontologic sensitivity. Quaternary alluvium of Holocene age present at the surface also has low paleontologic sensitivity, although in many cases this Holocene alluvium overlies older, fossiliferous sediments.

The San Diego Coastal Plain is a geomorphic region lying west of the Peninsular Ranges that is characterized by elevated Quaternary marine and fluvial terraces that have been dissected by west-flowing streams and rivers. The Coastal Plain region is underlain by a "layer cake" sequence of marine and non-marine sedimentary rock units that record portions of the last 140 million years of earth history (Gastil and Higley, 1977). Over this period of time the relationship of land and sea has fluctuated drastically such that today there are ancient marine rocks preserved up to elevations around 900 feet above sea level and ancient river deposits as high as 1,200 feet. Geologic conditions along the proposed alternative rail line alignments consist of late Pleistocene- to Holocene-age fluvial and/or alluvial deposits mapped as Quaternary alluvium, late Pleistocene-age river terrace deposits, late Pleistocene-age marine sandstones of the Bay Point Formation, early Pleistocene-age terrace deposits of the Lindavista Formation, late Pliocene-age marine sandstones of the San Diego Formation, middle Eocene-age fluvial and marine sandstones of the Mission Valley Formation, middle Eocene-age fluvial and marine sandstones and conglomerates of the Stadium Conglomerate and Friars Formation, middle Eocene-age sandstones and siltstones of the Scripps Formation and Ardath Shale, and late Jurassic to early Cretaceous-age metavolcanics and metasediments of the Santiago Peak Volcanics.

The Peninsular Range Region is underlain primarily by plutonic (i.e., granitic) rocks that formed from the cooling of molten magmas deep within the earth's crust. These magmas were generated during subduction of an oceanic crustal plate that was converging on the North American Plate between 140 and 90 million ybp (Krummenacher *et al*. 1975). Over this long period of time, extensive masses of granitic rocks accumulated at depth. Intense heat associated with these plutonic intrusions metamorphosed the ancient sedimentary rocks that were already here. These metasediments are now preserved in the Peninsular Range Region as marbles, slates, schist, quartzites, and gneiss. Geologic conditions along the proposed rail line alternatives consist of late Pleistocene- to Holocene-age fluvial and/or alluvial deposits mapped as Quaternary alluvium, and early Cretaceous-age gabbro, granodiorite, and tonolite of the Southern California Batholith (Larsen, 1948).

Numerous geologic formations with high paleontologic sensitivity occur along the proposed alignment within the APE. These formations include, from oldest to youngest: the Silverado Formation (Paleocene Epoch, 65 million ybp to 55 million ybp); the Ardath Shale (early middle Eocene Epoch, 48 million ybp to 45 million ybp); the Scripps Formation (early middle Eocene Epoch, ~47 million ybp); the Friars Formation (middle Eocene Epoch, ~46 million ybp); the Stadium Conglomerate (middle Eocene Epoch, ~45 million ybp to ~43 million ybp); the Mission Valley Formation (later Eocene Epoch; radiometrically date to 42.18 million ybp); the Puente Formation (later Miocene Epoch, ~12 million ybp to ~7 million ybp); the Fernando Formation (latest Miocene Epoch to early Pliocene Epoch, ~5 million ybp to ~3 million ybp); an unnamed sandstone and conglomerate formation described by Kennedy (1977) (later Pliocene Epoch to early Pleistocene Epoch, ~2.5 million ybp to ~500,000 ybp); the Lindavista Formation (early to middle Pleistocene Epoch, 1.5 million ybp to ~500,000 ybp); the sandstone unit of the Pauba Formation (middle Pleistocene Epoch, ?<500,000 ybp); the Bay Point Formation (later Pleistocene Epoch, ~220,000 ybp); terrace deposits (middle to later Pleistocene Epoch, ~500,000 ybp to ~11,000 ybp); older alluvium (middle to late Pleistocene Epoch, ~250,000 ybp to ~11,000 ybp); and recent (Holocene Epoch) alluvium, including basin fill, fan deposits, and wash sediments. Additionally, exposures of the undifferentiated Sespe and Vaqueros Formations (Oligocene Epoch, 34 million ybp to 24 million ybp) crop out near the APE in the Temescal Canyon region.

2.3 DATA SOURCES

Records searches were obtained from the Regional Paleontologic Locality Inventory (RPLI) at the SBCM, as well as from the Department of Vertebrate Paleontology, Natural History Museum of Los Angeles County (NHMLAC) and the Department of Paleontological Services, San Diego Natural History Museum (SDNHM). Plotted locality data and computerized locality records are also available from the RPLI at the SBCM; these data were collated by the staff of the SBCM for this report.

2.4 PALEONTOLOGIC LOCALITIES

Paleontologic resource localities are those sites where the fossilized remains of extinct animals and/or plants have been preserved. Generally speaking, fossils are preserved remnants of past life. In rare cases, plant and animal body parts may become incorporated into the lithosphere. This procedure, known as fossilization, is extremely infrequent when measured in "normal" time, but over the course of geological time has resulted in the preservation of abundant remains of past organisms.

In California, the rich geologic record of the state has resulted in numerous rock units with high paleontologic sensitivity being exposed at the surface. For this reason, the fossil record of California is exceptionally prolific, with abundant fossils representing diverse organisms having been recovered from rocks dating from more than one billion years before present (ybp), during the later Proterozoic Era, to the end of the Pleistocene Epoch around 11,000 ybp. These fossils have provided key data for charting the course of the evolution and extinction of life on the planet, both locally and globally, as well as for determining paleoenvironmental conditions, sequences and timing of sedimentary deposition, and other details of past millennia. Fossil-bearing rock units occurring within the APE of the proposed project are discussed briefly below.

SILVERADO FORMATION

The oldest fossil-bearing rock unit exposed within the proposed APE is the Silverado Formation. This Paleocene rock unit contains coal seams, lignite beds and commercial clay deposits, as well as abundant fossil mollusks (Woodring and Popenoe, 1945). Surface and subsurface exposures of this rock unit crop out along and near the proposed APE in Temescal Valley, along Segment 2 of the Highway Modal Alternative.

ARDATH SHALE

The Ardath Shale consists primarily of gray shale, siltstone and interbedded sandstones. It is well exposed in Rose Canyon and in road cuts along Morena Boulevard south to Tecolote Canyon. Spectacular outcrops of the Ardath Shale occur in the seacliffs from Torrey Pines south to Scripps Institution of Oceanography. This formation was deposited at outer shelf depths on an ancient sea floor during the early middle Eocene, about 47-48 Ma. The Ardath Shale has yielded diverse and well-preserved assemblages of marine microfossils (Bukry and Kennedy, 1969; Gibson, 1971; Steineck *et al.*, 1972), macroinvertebrates (Hanna, 1927; Givens and Kennedy, 1979), and vertebrates (e.g., sharks, rays, and bony fish).

SCRIPPS FORMATION

The Scripps Formation (Kennedy and Moore, 1971; Kennedy, 1975) consists of interbedded layers of claystones, siltstones, and sandstones, with some cobble conglomerate. In its type area, in the high sea cliffs north of La Jolla, the formation is 185 feet thick. The formation (May, 1985) is entirely of marine origin (continental shelf) and was deposited during the early middle Eocene, approximately 47 Ma. The Scripps Formation is considered to be potentially fossiliferous almost everywhere it occurs. Most of the fossils known from this formation consist of remains of marine organisms including clams, snails, crabs, sharks, rays, and bony fishes (Givens and Kennedy, 1975). However, remains of fossil reptiles (e.g., crocodile and turtle) and land mammals (e.g., uintathere, brontothere, rhinoceros, and artiodactyl) have also been recovered from the formation (Golz and Lillegraven, 1977; Walsh, 1991). Well-preserved pieces of fossil wood have also been recovered from the Scripps Formation.

FRIARS FORMATION

The Friars Formation as initially described by Kennedy and Moore (1971) consists of light gray, medium-grained sandstones; greenish, reddish, and brown siltstones and mudstones; and common lenses of cobble conglomerate. Based on new paleontological and geological data, however, Walsh *et al*. (1996) have revised the stratigraphy of the Friars Formation and subdivided it into three informal units or tongues including a lower white medium-grained sandstone tongue, a middle pebble to boulder conglomerate tongue, and an upper white medium-grained sandstone tongue. Walsh *et al*. (1996) have also demonstrated that rocks previously mapped (Kennedy, 1975) as Stadium Conglomerate and Mission Valley Formation in the Scripps Ranch, Rancho Penasquitos, and Rancho Bernardo areas are actually correlative with their middle conglomerate and upper sandstone tongues, respectively, of the Friars Formation. As redefined by Walsh *et al*. (1996) the Friars Formation is almost entirely fluvial in origin, although occasional estuarine facies occur toward the western end of its outcrop area. The Friars Formation is middle Eocene in age, approximately 46 Ma. The Friars Formation is rich in vertebrate fossils, especially terrestrial mammals such as opossums, insectivores, primates, rodents, artiodactyls, and perissodactyls (Golz and Lillegraven, 1977; Walsh, 1996). Also reported from the Friars Formation are sparse remains of brackish water and estuarine molluscs (Walsh *et al*., 1996). Impressions of fossil leaves have also been recovered from the Friars Formation.

STADIUM CONGLOMERATE

The Stadium Conglomerate (Kennedy and Moore, 1971) has been subdivided into upper and lower conglomeratic members by Walsh *et al*. (1996). The lower unit is composed of light green-gray, poorly sorted cobble conglomerate with a muddy to sandy matrix, and a thickness 10-100 feet. Disconformably overlying this lower unit is an upper conglomeratic unit, consisting of 50-100 feet of reddish-tan, well sorted, cobble conglomerate. The upper and lower conglomeratic units are in depositional contact in the Mission Valley and Murphy Canyon areas. However, to the north and east, the upper member appears to be absent. Fossil foraminifers and marine molluscs (Givens and Kennedy, 1979) have been collected from the upper member of the Stadium Conglomerate in the western part of the old Fenton Quarry in Murray Canyon. The upper member is largely non-marine in the eastern part of its outcrop area. Collecting sites in Murphy Canyon have yielded sparse, but well-preserved remains of opossums, insectivores, primates, rodents, carnivores, rhinoceros, and artiodactyls (Walsh, 1996). Milow and Ennis (1961) noted that in Mission Valley, sparse marine fossil remains occur near the base of what is here called the lower member of the Stadium Conglomerate. Exposures of the lower member at Scripps Ranch are primarily non-marine and have produced well-preserved remains of land mammals including opossums, insectivores, primates, rodents, carnivores, and artiodactyls (Walsh, 1996). The majority of the fossils recovered from the lower member were found in either claystone rip-up clasts or in the sandy matrix characteristic of certain channel-fill deposits in this rock unit.

MISSION VALLEY FORMATION

The Mission Valley Formation in its type area in Mission Valley consists of light gray, fine-grained marine sandstones (Kennedy and Moore, 1971). In the eastern and southern portions of its area of outcrop, the formation consists largely of medium-grained, fluvial sandstones and green and brown non-marine mudstones. It reaches a maximum known thickness of about 200 feet in Mission Valley, and is only about 45 feet thick in the northeastern part of Tierrasanta and 60 feet thick at Scripps Ranch. From there it steadily thins to the east. The Mission Valley Formation has been dated with the Ar-Ar method at 42.18 million ybp (J.D. Obradovich, cited in Berry, 1991), and is the only Eocene rock unit in southern

California to have a radiometric date directly associated with fossil mammal localities. The marine strata of the Mission Valley Formation have produced abundant and generally well-preserved remains of marine microfossils (e.g., foraminifers), macroinvertebrates (e.g., clams, snails, crustaceans, and sea urchins), and vertebrates (e.g., sharks, rays, and bony fish) (Givens and Kennedy, 1979; Roeder, 1991). Fluvial strata of the Mission Valley Formation have produced well-preserved examples of petrified wood and fairly large and diverse assemblages of fossil land mammals including opossums, insectivores, bats, primates, rodents, artiodactyls, and perissodactyls (Walsh, 1996). The co-occurrence in the Mission Valley Formation of land mammal assemblages with assemblages of marine microfossils, molluscs, and vertebrates is extremely important as it allows for the direct correlation of terrestrial and marine faunal time scales. The Mission Valley Formation represents one of the few instances in North America where such comparisons are possible (Walsh, 1996).

UNDIFFERENTIATED SESPE AND VAQUEROS FORMATIONS

Also exposed at the surface near the proposed APE along Segment 2 of the Highway Modal Alternative in Temescal Canyon are undifferentiated rocks of the Sespe and Vaqueros Formations. These formations are nonmarine and marine, respectively, and interfinger across an ancient, broad coastal plain that now includes portions of Corona and Temescal Canyon. Sediments of the marine Vaqueros Formation have yielded fossil remains of plants, clams, snails, crabs, sharks and rays. The nonmarine sediments of the Sespe Formation have yielded fossil remains of extinct insectivores, primates, carnivorans, rodents, oreodonts, rhinos, and camels. Exposures of the undifferentiated Sespe and Vaqueros Formations do not occur at the surface within the proposed APE, but are present very near the APE in the Temescal Valley and so may be present in the subsurface along the APE.

PUENTE FORMATION

Surface exposures of the Puente Formation are crossed by portions of HST Segments 1-A-1 and 1-B-1, as well as by Segment 1 of the Modal Alternative, in the Puente Hills region of eastern Los Angeles County and western San Bernardino County. The highly fossiliferous Puente Formation was initially named by Eldridge and Arnold (1907) from exposures in the Puente Hills. The Puente Formation is considered to be equivalent to the Upper Miocene Monterey Formation (Blake, 1856), which is widespread in the Coast Range province of California as well as in the Palos Verdes Hills and the San Juan Capistrano area (Bramlette, 1946; Vedder *et al.*, 1957; Vedder, 1975; Woodring *et al.*, 1940; Woodring *et al.*, 1946; Schoellhamer *et al.*, 1981).

Outcrops of the Puente Formation in the Santa Ana Mountains and Puente Hills exhibit siliceous, diatomaceous, and organic siltstones and shales that also characterize exposures of the Monterey Formation elsewhere in southern California. The Puente Formation is distinctive, however, in that it further contains thick and widespread coarse clastic material; even the finer-grained sediments of the Puente Formation are more clastic than those of the Monterey Formation (Schoellhamer *et al.*, 1981). These dissimilar lithologies serve to distinguish the Puente from the Monterey, and suggest different depositional environments for the two formations (Durham and Yerkes, 1964; Schoellhamer *et al.*, 1981).

The Puente Formation was originally divided into three members (English, 1926): a lower shale, a middle sandstone, and an upper sequence of siltstone, sandstone and conglomerate. The overlying Sycamore Canyon conglomerate and interbedded sandstone and siltstone was originally considered separate from the Puente Formation (English, 1926). Daviess and Woodford (1949), however, later included the Sycamore Canyon sediments as the uppermost subdivision of the Puente Formation. Richmond (1952) modified English's (1926) usage to make it consistent with that of Daviess and Woodford (1949). Schoellhamer *et al.* (1954) formally named the four members of the Puente Formation; in ascending order, these are the La Vida, Soquel, Yorba, and Sycamore Canyon Members.

Sediments of the Puente Formation are highly fossiliferous, and have yielded an extensive and varied fauna including marine and terrestrial invertebrates, vertebrates, and plants. The RPLI at the SBCM contains records of nearly three hundred paleontologic resource localities from this formation.

FERNANDO FORMATION

Surface exposures of the fossiliferous Fernando Formation crop out in the eastern Los Angeles County area along the proposed APE of Segment 1-A-1, as well as along Segment 1 of the Modal Alternative. The marine Fernando Formation is Pliocene in age and consists of both an upper member and a lower member. In the Los Angeles area, the upper Pico Member of the Fernando Formation is comprised of sandy siltstone, sandstone, and conglomerate. This member rests above a lower member of siltstone, fine sandstone, and conglomerate, known as the Repetto Member (Dibblee, 1987a). Within Ventura and Los Angeles counties, the Fernando Formation is approximately 3000 meters (10,000 feet) thick and contains the fossils of marine invertebrates including bivalves and snails, along with vertebrates including sharks (*Carcharodon sulcidens, C. carcharias, Isurus oxyrinchus*), rays (*Myliobatis*), bony fishes (*Semicossyphus, Cyclothone*), and whales (Cetacea). Terrestrial taxa recovered from the Fernando Formation include bird (*Mancalla*), camel (Camelidae), and tapir (Tapiridae).

UNNAMED SANDSTONE AND CONGLOMERATE FORMATION OF KENNEDY (1977)

Throughout the Murrieta and Temecula regions of western Riverside County, surface sediments consist of the Pauba Formation and an underlying unnamed sandstone and conglomerate formation first diagnosed by Kennedy (1977). The unnamed sandstone and conglomerate formation crops out at the surface extensively along the proposed APE for Segment 2 of the Highway Modal Alternative, as well as to a lesser degree along portion of the proposed APE of Segment 2-A-1. It also underlies surface exposures of the Pauba Formation throughout the Murrieta and Temecula region.

The unnamed sandstone and conglomerate formation has been demonstrated to be highly fossiliferous throughout the Murrieta/Temecula region. Vertebrate fossils recovered from the sandstone member of this formation include mammoths, mastodons, ground sloths, dire wolves, short-faced bears, tapirs, horses, camels and llamas, along with abundant (and in many cases temporally-diagnostic) small vertebrates and invertebrates (Reynolds and others, 1991; Scott, 1992, 1998, 1999; Scott and Cox, 1993; Pajak, Scott and Bell, 1996). The formation has also yielded remains of the extinct giant teratorn *Aiolornis incredibilis*, the largest flying bird known from North America (Campbell, Scott and Springer, 1999).

The unnamed sandstone formation has been dated in part to the Blancan North American Land Mammal Age (NALMA) (= later Pliocene Epoch) and in part to the Irvingtonian NALMA (= early Pleistocene Epoch) (Scott and Cox, 1993; Pajak, Scott and Bell, 1996). A kaolin deposit interstratified with exposures of this sandstone has been correlated with the widespread Bishop Tuff (Kennedy, 1977). The Bishop Tuff has been radiometrically dated to the middle Pleistocene Epoch, ± 0.758 million years BP (Merriam and Bischoff, 1975).

LINDAVISTA FORMATION

The Lindavista Formation (Kennedy, 1975) represents a marine and/or non-marine terrace deposit of early Pleistocene age (approximately 0.5-1.5 Ma). Typical exposures of the formation consist of rust-red, coarse-grained, pebbly sandstones and pebble conglomerates with locally common deposits of green claystone. The Lindavista Formation has an average thickness of about 20-30 feet and is thought to have been deposited under fluvial, aeolian, and shallow nearshore marine conditions (Kennedy, 1975). These deposits accumulated on a flat, wave-cut platform (i.e., sea floor) during a period of dropping sea levels. Today, these deposits form the extensive mesa surfaces characteristic of the Linda Vista Mesa, Kearny Mesa, and Mira Mesa areas. Fossil localities are limited in the Lindavista Formation and have been recorded from only a few areas (e.g., Tierrasanta, Mira Mesa, Kearney Mesa, and San Diego Mesa). Fossils collected from these sites consist of remains of nearshore marine invertebrates including clams, scallops, snails, barnacles, and sand dollars (G.L. Kennedy, 1973), as well as sparse remains of sharks and baleen whales (Deméré and Walsh, 1993).

PAUBA FORMATION

The fossiliferous Pauba Formation crops out at the surface in the Murrieta and Temecula regions along the proposed APEs for Segment 2-A-1 and along Segment 2 of the Highway Modal Alternative. The Pauba Formation unconformably overlies the above-described unnamed sandstone of Kennedy (1977) as well as a second fossil-bearing formation, the Temecula Arkose. The Pauba Formation has been dated (Mann, 1955; Pajak *et al*., 1996) to the middle Pleistocene Epoch (= < 750,000 years BP) on the basis of vertebrate fossils recovered from the formation.

The Pauba Formation was initially described as “including 250 feet of hardpan-lithified fanglomerates, yellow and red arkoses, brown silts, and diatomite (Mann 1955, p. 3).” Subsequent mapping by Kennedy (1977) revised Mann’s (1955) work, and recognized two distinct lithologic units in the Pauba Formation:

> “(1) a light-brown, moderately well-indurated, extensively crossbedded, channeled and filled sandstone and siltstone facies that contains occasional intervening cobble-and-boulder conglomerate beds and (2) a grayish-brown, well-indurated, poorly sorted fanglomerate and mudstone facies (Kennedy 1977, p. 5).”

Of these lithologies, the sandstone lithology of the fossiliferous Pauba Formation has been demonstrated to be highly fossiliferous throughout its extent. It is this lithology that is exposed within the APEs of Segment 2-A-1 as well as Segment 2 of the Highway Modal Alternative. Vertebrate fossils recovered from the Pauba Formation include mammoths, mastodons, ground sloths, sabre-toothed cats, tapirs, horses, camels and llamas, as well as abundant small vertebrates (Reynolds *et al*., 1991; Bowden and Scott, 1992; Scott, 1992, 1998, 1999; Pajak, 1993; Scott and Cox, 1993; Pajak, Scott and Bell, 1996).

BAY POINT FORMATION

The Bay Point Formation (Hertlein and Grant, 1939) is a nearshore marine sedimentary deposit of late Pleistocene age (approximately 220,000 years old). Typical exposures consist of light gray, friable to partially cemented, fine- to coarse-grained, massive and cross-bedded sandstones. The formation is generally exposed at sea level, so its total thickness and relationship with underlying formations is unknown. The Bay Point Formation has produced large and diverse assemblages of well-preserved marine invertebrate fossils, primarily molluscs (Stephens, 1929; Hertlein and Grant, 1939; Valentine, 1959; Deméré, 1981). However, remains of fossil marine vertebrates (i.e., sharks, rays, and bony fishes) have also been recovered from this rock unit. Recorded collecting sites in the Bay Point Formation include both natural exposures (e.g., sea cliffs) as well as construction-related excavations.

QUATERNARY TERRACE DEPOSITS

Deposits of coarse-grained, gravelly sandstones, pebble and cobble conglomerates, and claystones have been mapped along the margins of Mission Valley, Rose Canyon, and Murphy Canyon. These deposits generally occur at levels above the active stream channels and represent the sediments of ancient river courses. The exact age of these deposits is presently uncertain but they are clearly related to late Pleistocene (10,000 to 500,000 years old) climatic events. As mapped, these river terrace deposits probably represent several different depositional systems and time periods. They are here lumped together because presently there is insufficient stratigraphic data available with which to differentiate them. Fossils have been collected from river terrace deposits at several locations in coastal San Diego County. These locations include the south side of Sweetwater Valley, where fluvial sandstones and siltstones have produced well-preserved remains of pond turtle, passenger pigeon, hawk, mole, gopher, squirrel, rabbit, and horse (Majors, 1993); the South Bay Freeway (SR-54), where fluvial siltstones have yielded a diverse assemblage of "Ice Age" mammals (ground sloth, shrew, mole, mice, wolf, camel, deer, horse, mastodon, and mammoth); and San Dieguito Valley, where fluvial sandstones have produced well-preserved remains of ground sloth. All of these important sites have been discovered in construction-related excavations.

QUATERNARY OLDER ALLUVIUM

Abundant surface exposures of Quaternary older alluvium deposited during the Pleistocene Epoch are present along the proposed routes and within the proposed APEs for Segments 1-A-1, 1-A-2, 1-A-3, 1-A-4, 1-B-1, 1-C-1, and Segment 2-A-1, as well as along Segments 1, 2 and 3 the Highway Modal Alternative. Depending upon lithology, these sediments can have high potential to contain significant nonrenewable paleontologic resources. Older Pleistocene alluvium elsewhere in the Los Angeles Basin and throughout the Inland Empire has demonstrated high potential to contain nonrenewable fossil resources (Miller, 1971; Jefferson, 1991; Reynolds and Reynolds, 1991; Woodburne, 1991; Springer and Scott, 1994; Scott, 1997; Springer *et al.*, 1998, 1999). Fossils recovered from these Pleistocene sediments represent extinct taxa including mammoths, mastodons, ground sloths, dire wolves, short-faced bears, sabre-toothed cats, large and small horses, large and small camels, and bison (Jefferson, 1991; Reynolds and Reynolds, 1991; Woodburne, 1991; Springer and Scott, 1994; Scott, 1997; Springer *et al.*, 1998, 1999), as well as plant macro- and microfossils (Anderson *et al.*, 2002). Fossils are generally unknown from the Quaternary alluvial deposits in the Coastal Plain of San Diego County, but there are two notable exceptions. A fragmentary mammoth tusk was found in alluvial deposits in the southwestern portion of El Cajon Valley, while a mammoth femur was recovered from alluvial deposits in the Santa Margarita River channel at the south end of the Camp Pendleton Marine Corps Base.

3.0 METHODS FOR PALEONTOLOGIC RESOURCES ANALYSIS

The paleontologic resources analysis for this program-level EIR/EIS is focused on a broad comparison of potential impacts to significant nonrenewable paleontologic resources along corridors for each of the alternatives (high-speed train and modal alternatives) and around stations. The potential impacts for each of these alternatives are compared with the No-Project Alternative.

3.1 DATA COLLECTION

An Area of Potential Effect (APE), or study area, was defined for the project. The APE for paleontologic resource localities was defined as 100 feet on each side of the centerline of proposed rail routes. The APE for freeway routes and around airports was defined as 100 feet beyond the existing freeway right-of-way and 100 feet beyond the existing airport property boundary. In non-urban areas, the APE may require expansion to 500 feet on each side of the proposed project centerline if subsequent design features indicate that paleontologic resources beyond the presently defined APE might be affected.

Records searches were obtained from the RPLI at the SBCM, as well as from the NHMLAC and the SDNHM as described above. The records searches provided the locations of known paleontologic localities within the APE. The number of paleontologic resource localities within the APE for each alternative was compared to assess the relative degree of potential impacts or effects for each alternative.

3.2 LEGAL CITATIONS REGARDING THE PROTECTION AND PRESERVATION OF PALEONTOLOGIC RESOURCES

3.2.1 Federal Regulations

Statutes of the United States of America that incorporate provisions for the protection of paleontologic resources include:

Federal Antiquities Act of 1906 (P.L. 59-209, 32 Stat. 225).

Forbids and establishes criminal sanctions for disturbance of any object of antiquity on Federal land without a permit issued by an authorizing authority.

National Environmental Policy Act of 1969

(P.L. 91-190, 83 Stat. 852, 42 USC 4321-4327). Mandates policies to “preserve important historic, cultural and natural aspects of our national heritage” (Section 101.b4).

3.2.2 State of California -- Requirements

Fossil remains are a limited, nonrenewable, highly sensitive, scientific resource. In California, these resources are afforded protection against adverse impacts under the authority of the following State of California legislation (California Office of Historic Preservation, 1983):

California Environmental Quality Act of 1970

(13 Public Resources Code, 21000 et seq). Requires public agencies and private interests to identify the potential adverse impacts and/or environmental consequences of their proposed

project(s) to any object or site scientific to the scientific annals of California (Division 1, Public Resources Code: 5020.1 [b]).

Guidelines for the Implementation of CEQA (as amended 1 January 1999)

(CEQA Guidelines Sec. 15064.5). Provides protection for paleontologic resources by requiring that they be identified and mitigated as historical resources under CEQA. The CEQA Guidelines define historical resources broadly to include any object, site, area or place that a lead agency determines to be historically significant. The regulation goes on to provide that generally, a resource shall be considered "historically significant" if it has yielded or may be likely to yield information important in prehistory. Paleontologic resources fall within this broad category, and additionally are included in the CEQA checklist under "Cultural Resources."

Warren-Alquist Act

(PRC 25000 et seq.). Requires the California Energy Commission to evaluate energy facility siting in unique areas of scientific concern (section 25527).

Public Resources Code, Section 5097.5

(Stats 1965, c. 1136, p. 2792). Prohibits excavation or removal of any "...vertebrate paleontological site...or any other archaeological, paleontological or historical feature, situated on public lands, except with the express permission of the public agency having jurisdiction over such lands." Public lands are defined to include lands owned by or under the jurisdiction of the State of California or any city, county, district, authority or public corporation, or any agency thereof. Defines any unauthorized disturbance or removal of paleontologic, archaeologic and/or historic materials or sites located on public lands as a misdemeanor.

Public Resources Code, Section 30244

Requires reasonable mitigation of adverse impacts to paleontological resources from development on public land.

3.3 INTERPRETING PALEONTOLOGIC SENSITIVITY

Under both state and federal guidelines for cultural resources (including paleontologic resources), impacts are potentially significant only if the resource being impacted has been determined to be significant. Section V(c) of Appendix G of CEQA makes reference to "unique paleontological resource(s) or site(s) or unique geological feature(s)". No definition of what constitutes a "unique" resource or site is provided. Some interpretation is therefore necessary to provide proper resource protection.

3.3.1 Paleontologic Resources

Paleontologic resources are the fossilized evidence of past life found in the geologic record. Despite the tremendous volume of sedimentary rock deposits preserved worldwide, and the enormous number of organisms that have lived through time, preservation of plant or animal remains as fossils is an extremely rare occurrence. Because of the infrequency of fossil preservation, fossils -- particularly vertebrate fossils -- are considered to be nonrenewable resources. Because of their rarity, and because of the scientific information they can provide, fossils are highly significant records of ancient life. They can provide information about the interrelationships of living organisms, their ancestry, their development and change through time, and their former distribution. Progressive morphologic changes observed in fossil lineages may provide critical information on the evolutionary process itself -- that is, the ways in which new species arise and adapt to changing environmental circumstances. Fossils can also serve as important guides to the ages of the rocks and sediments in which they are contained, and may prove useful in determining the temporal relationships of rock deposits from one area to another and the timing of geologic events. Time scales established by fossils provide chronologic frameworks for geologic studies of all kinds.

3.3.2 Defining Paleontologic Significance

Because of the infrequency of fossil preservation, fossils are considered to be nonrenewable resources. Because of their rarity, and because of the scientific information they provide, fossils can be highly significant records of ancient life. Given this, fossils can be considered to be of significant scientific interest if one or more of the following criteria apply:

1.) The fossils provide data on the evolutionary relationships and developmental trends among organisms, both living and extinct;

2.) The fossils provide data useful in determining the age(s) of the rock unit or sedimentary stratum, including data important in determining the depositional history of the region and the timing of geologic events therein;

3.) The fossils provide data regarding the development of biological communities or interaction between paleobotanical and paleozoological biotas;

4.) The fossils demonstrate unusual or spectacular circumstances in the history of life; and/or

5.) The fossils are in short supply and/or in danger of being depleted or destroyed by the elements, vandalism, or commercial exploitation, and are not found in other geographic locations.

As so defined, significant paleontologic resources are determined to be fossils or assemblages of fossils that are unique, unusual, rare, uncommon, diagnostically or stratigraphically important, and/or those that add to an existing body of knowledge in specific areas -- stratigraphically, taxonomically, and/or regionally. They can include fossil remains of large to very small aquatic and terrestrial vertebrates, remains of plants and animals previously not represented in certain portions of the stratigraphy, and fossils that might aid stratigraphic correlations, particularly those offering data for the interpretation of tectonic events, geomorphologic evolution, paleoclimatology, and the relationships of aquatic and terrestrial species.

Determinations of the significance of paleontologic resources can only be made by qualified, trained paleontologists familiar with the fossils under consideration. Such determinations are best advanced in the light of a well-conceived and clearly defined treatment plan. With an efficient sampling plan based upon such a treatment program in effect, the ability of the paleontologists to recognize, recover and preserve significant paleontologic resources is greatly enhanced.

3.3.3 Determining Paleontologic Significance

The guidelines for significance identified above all have in common one basic assumption: that the fossils in question have been identified to a reasonably precise level, preferably to the generic or the specific level. *All identifiable paleontologic resources are always potentially significant.* In general, fossils are not considered to be significant unless they can be identified with some degree of precision. It is of course true that there are exceptions to this rule; unidentifiable bones or bone fragments, for example, can be of great significance when recovered from a sedimentary unit or formation which previously had not yielded fossils, or from an area with little or no history of paleontologic sensitivity. Fossils of animals that are rare in faunal assemblages may provide significant information even when only identifiable to class, ordinal or familial level (e.g., Carnivora). And fossil fragments exhibiting weathering, abrasion, wear, or other indications of significant taphonomic processes can also be important in reconstructing site-specific depositional processes. However, questions of evolutionary relationships, age of the deposit, and so forth -- those questions that are generally employed to determine the significance of a paleontologic resource -- cannot be reasonably addressed until the fossils under study have been identified to a relatively precise degree. Viewed in this light, unidentifiable fossils or fossil fragments can be seen to have little scientific significance.

In the context of paleontologic mitigation, detailed collection practices (i.e. academically-driven research designs where every bone and/or bone fragment is analyzed) are not always feasible. Destruction of at least some paleontologic resources is an unavoidable consequence of development-related excavation. Clearly, then, the goal of the paleontologists(s) in this context is not to *eliminate* impacts to fossil resources, but rather to *mitigate* such impacts by protecting fossils from physical damage whenever possible, and by emphasizing collection of a representative sample of the entire potential assemblage. In this manner, adverse impacts are reduced to an insignificant level. In such cases, unidentifiable bones or bone fragments may *not* be considered to be potentially significant in terms of the criteria presented above (Section 3.1), since identification is usually an essential prerequisite to determining significance -- and there may be little chance of ever supplementing these specimens with their missing portions or advancing more detailed identifications at some future date. Further, isolated fragments cannot always be placed in a sufficiently detailed three-dimensional context with their missing portions to enable taphonomic data to be advanced with any reliability.

For these reasons, nondiagnostic bones or unidentifiable bone fragments of extinct animals identified from within the APE are determined to be scientifically significant only in a limited sense. In general, where exposed such elements will be employed by field monitors as indicating sediments or outcrops that *demonstrably* contain fossil resources; these areas will be examined and test-sampled to determine the presence of more complete -- and therefore more significant -- paleontologic resources. Fossil fragments encountered in quarry situations are an exception to this condition, as such elements may reattach to other broken fossils from the quarry. Such fragments might also assist in advancing taphonomic interpretations elucidating the formation of the assemblage. Fossil fragments exhibiting weathering, wear, abrasion, or other indications of significant taphonomic processes may also be collected. Microfossils are another evident exception. These elements -- generally not visible to the naked eye in the field -- are obtained through recovery of bulk samples of fossiliferous sediments that are washed and processed in the laboratory. Some unidentifiable microfossil remains are an unavoidable circumstance of this collection procedure (although most fossils recovered in this manner are readily identifiable).

Regarding those fossil remains identified from the APE that *are* identifiable, it is reiterated that all identifiable paleontologic resources are always potentially significant. This being the case, the question of determining potential significance thus becomes one of where the identifications of the resource(s) are made -- in the field, before physical recovery of the resource, or in the laboratory subsequent to recovery and preparation. In some rare cases, accurate identifications of distinctive fossil elements to the genus or species level -- and subsequent determinations of significance -- are possible in the field. In most cases, however, accurate genus- or species-level identifications of megafaunal remains are not possible in the field for the following reasons: 1.) the resource(s) are generally not sufficiently well-exposed and visible to permit accurate field identification; 2.) the resource(s) have generally suffered damage from equipment activity, which makes field identification(s) much more difficult; 3.) many bones of comparably sized animals (for example, limb bones and vertebrae of camels and horses) are very similar in overall appearance, and are difficult to discriminate without the aid of a well-provisioned comparative osteological collection; and 4.) in the context of an excavation that is proceeding according to a defined schedule, precise identification in the field is neither efficient nor cost effective. Microfaunal remains offer an additional challenge, as these elements are generally not visible to the naked eye in the field; rather, they are recovered in the laboratory through processing of bulk samples of fossiliferous sediments.

Given the above, paleontologic field monitors are primarily trained and responsible for the collection of resources which exhibit distinctive features such as articular surfaces, bony spines, or prominent bony ridges which will enable detailed identifications to be made later, in the laboratory. Resources that do not appear to be *potentially* diagnostic in this manner are generally not collected, although their presence in the field may be recorded in field notes.

Any of the fossil resources that appear in the field to be diagnostic are *potentially* significant in that they could provide data crucial to resolving any number of research questions under consideration by paleontologic investigators -- both presently and in the future. Since this significance in most cases cannot be accurately (or cost-effectively) determined prior to recovery of the resource(s), it is most reasonable and efficient to recover *all* diagnostic or potentially-diagnostic resources as they are exposed with the aim that these resources will, utilizing any number of techniques, be later demonstrated to be scientifically significant.

The resolution of specific questions or issues (as outlined in the significance criteria presented above) can be attempted given certain volumes of certain types or kinds of fossil remains. However, while estimates of the sufficiency of data -- that is, the number of specimens required to properly address a given question or issue -- can be advanced *a priori*, such estimates should by no means be considered final. The acquisition of a quantity of specimens sufficient to address a given research question does not imply that no more specimens of a similar nature need to be collected. In most cases, the recovery of minimally sufficient numbers of specimens does not imply that “additional” remains are not significant. Rather, estimates of sufficiency should be employed only to determine that it has become possible to *begin* to address a particular question. Nor can such estimates be treated in isolation, without also considering estimates of “sufficiency of data” necessary for the resolution of other paleontologic questions.

3.4 DETERMINATIONS OF ROCK UNIT SENSITIVITY

Sedimentary units which are paleontologically sensitive are those units with a high potential for containing significant paleontologic resources -- that is, rock units within which vertebrate fossils or significant invertebrate fossils have been determined by previous studies to be present or likely to be present. These units include, but are not limited to, sedimentary formations that contain significant paleontologic resources anywhere within their geographical extent, as well as sedimentary rock units temporally or lithologically suitable for the preservation of fossils. Determinations of paleontologic sensitivity must therefore consider not only the potential for yielding abundant vertebrate fossils but also the potential for production of a few significant fossils, large or small, vertebrate or invertebrate, which may provide new and significant taxonomic, phylogenetic, and/or stratigraphic data. Areas that may contain datable organic remains older than Recent and areas that may contain unique new vertebrate deposits, traces, and/or trackways must also be considered paleontologically sensitive.

3.4.1 Invertebrate Fossils

Generally, invertebrate fossils recovered from marine sediments are often widely distributed throughout a given outcrop or formation, are found in predictable locations, and are both abundant and well preserved. In fact, many invertebrate fossils -- particularly marine invertebrate fossils -- can sometimes number in the millions, and can be exposed over miles of outcrop. Some invertebrate fossils are so prolific that they constitute major rock material, such as diatomaceous clay.

Given these general observations, it is clear that sedimentary exposures containing abundant, well-preserved, and extensively-distributed invertebrates -- but lacking vertebrate fossils (see below) -- are less paleontologically sensitive than limited exposures containing few fossils from a restricted depositional zone -- for example, a narrow near-shore environment. In the first case, paleontologically significant data lost to adverse impacts (be such impacts development-related or otherwise) could very likely be easily recovered from any other exposures of the impacted formation which contained similar fossil density and species diversity. In the second instance, however -- that of the limited exposures from restricted depositional environments -- adverse impacts to paleontologic resources might not be ameliorated by fossil salvage elsewhere in the formation, since the fossil abundance and species representation would likely be very different. In this second case, the sediments under consideration would be determined to have higher paleontological sensitivity.

3.4.2 Vertebrate Fossils

Vertebrate fossils -- fossils representing animals with backbones, including mammals, birds, reptiles, amphibians and fish -- are much more rare than invertebrate fossils and are often more poorly preserved. In marine rock units, significant vertebrate fossils are generally much less common than invertebrate fossils. Paleontologic resource localities yielding vertebrate fossils are also frequently recovered from terrestrial (= non-marine) deposits; these continental deposits are generally less depositionally uniform than marine deposits, and fossilization is consequently even more infrequent. Further, in life vertebrates are often far less abundant than invertebrates (picture the difference between a herd of hundreds or even thousands of bison versus marine beds containing *hundreds of millions* of bivalves); the infrequency of fossilization and the vicissitudes of the many taphonomic factors involved result in vertebrate fossils being extremely rare relative to their original numbers in life. For these reasons, vertebrate fossil resources are considered to have very high paleontologic significance; geologic formations that have the potential to yield vertebrate fossil remains are therefore considered to have the greatest paleontologic significance -- and, it follows, the highest paleontologic sensitivity.

3.4.3 Definitions

Literature research and institutional records searches have resulted in the designation of areas within the APE as having high, low, or undetermined paleontologic sensitivity. Provisions for mitigation of adverse impacts to significant nonrenewable paleontologic resources present within the boundaries of the APE were based upon these determinations of potential paleontologic sensitivity. The terms “high sensitivity,” “low sensitivity,” and “undetermined sensitivity” are described below.

<u>High Sensitivity</u>: Sedimentary units with a high potential for containing significant nonrenewable paleontologic resources are determined to have high paleontologic sensitivity. In these cases the sedimentary rock unit contains a high density of recorded vertebrate fossil sites, has produced vertebrate fossil remains within the APE and/or the vicinity, and is very likely to yield additional remains within the APE.

<u>Low Sensitivity</u>: The rock unit contains no or very low density of recorded resource localities, has produced little or no fossil remains within the APE and/or the vicinity, and is not likely to yield any remains within the APE. [Note: elsewhere in southern California, sedimentary exposures with few or no prior recorded sites have recently proven abundantly fossiliferous during paleontologic mitigation activities for other construction projects. For example, the Diamond Valley Lake in Hemet, Riverside County, California was originally determined to have “low to moderate” sensitivity, but subsequently has yielded thousands of well-preserved fossils of terrestrial Pleistocene Epoch vertebrates (Springer and Scott 1994; Scott, 1997; Springer *et al.*, 1998, 1999) and plants (Anderson *et al.*, 2002)].

<u>Undetermined Sensitivity</u>: The rock unit has limited exposure(s) in the APE, is poorly studied, and contains no recorded paleontologic resource localities. However, in other areas, the same or a similar rock unit contains sufficient paleontologic resource localities to suggest that exposures of the unit within the APE have potential for yielding fossil remains.

4.0 PALEONTOLOGIC IMPACTS

The table below lists each segment of the Los Angeles County to San Bernardino County to Riverside County to San Diego County Region for the No-Project, Modal, and High Speed Train alternatives. The number of rock units having high paleontologic sensitivity and the number of paleontologic resource localities recorded within each APE were assessed in order to provide an accurate interpretation of the overall ranking of high, low, or undetermined potential to impact significant nonrenewable paleontologic resources. This final evaluation is reached using both the raw data in the table below and incorporating professional assessments by the paleontologic staff regarding the significance of recovered resources from exposed rock units, and the likelihood of these rock units to contain additional paleontologic resources. Brief discussions of the rationale behind these judgments are presented following the table in paragraphs discussing each segment and its evaluation.

	Formations with High Fossil Sensitivity	Formations with Low Fossil Sensitivity	Fossil Resource Localities Within APE	Fossil Resource Localities Near APE	Overall Rank	Subsequent Analysis
NO-PROJECT ALTERNATIVE						
NO-PROJECT	0*	0*	0*	0*	LOW*	N/A*
MODAL ALTERNATIVE						
SEGMENT 1	4; 5?	6; 7?	0	13	HIGH	PA-1 through PA-11, inclusive
SEGMENT 2	6	6	0	223	HIGH	PA-1 through PA-11, inclusive
SEGMENT 3	5	7	3	0	HIGH	PA-1 through PA-11, inclusive
HST CORRIDORS						
SEGMENT 1-A-1	3	2	0	5	HIGH	PA-1 through PA-11, inclusive
SEGMENT 1-A-2	1	3	0	12	HIGH	PA-1 through PA-11, inclusive
SEGMENT 1-A-3	1	4	0	0	HIGH	PA-1 through PA-11, inclusive
SEGMENT 1-A-4	1	1	0	0	HIGH	PA-1 through PA-11, inclusive

	Formations with High Fossil Sensitivity	Formations with Low Fossil Sensitivity	Fossil Resource Localities Within APE	Fossil Resource Localities Near APE	Overall Rank	Subsequent Analysis
SEGMENT 1-B-1	2	1	0	3	HIGH	PA-1 through PA-11, inclusive
SEGMENT 1-C-1	1	3	0	1	HIGH	PA-1 through PA-11, inclusive
SEGMENT 2-A-1	3; 4?	4; 5?	0	170	HIGH	PA-1 through PA-11, inclusive
SEGMENT 2-A-2	0; 1?	2; 3?	0	0	LOW	PA-1 through PA-3, inclusive
SEGMENT 2-A-3	2; 3?	2; 3?	0	0	HIGH	PA-1 through PA-11, inclusive
SEGMENT 2-B-1	0; 1?	2; 3?	0	0	LOW?	PA-1 through PA-3, inclusive
SEGMENT 3-A-1	3; 4?	0; 1?	0	5	HIGH	PA-1 through PA-11, inclusive
SEGMENT 3-B-1	6; 7?	1; 2?	0	1	HIGH	PA-1 through PA-11, inclusive
SEGMENT 3-B-2	4; 5?	1; 2?	0	27	HIGH	PA-1 through PA-11, inclusive
SEGMENT 3-C-1	2; 3?	0; 1?	0	0	HIGH	PA-1 through PA-11, inclusive

* The No-Project alternative includes improvements to highways and existing, conventional rail corridors by the year 2020. As environmental studies are being implemented independently for these improvements, they do not constitute part of this Project. Therefore, no additional impacts to paleontologic resources are expected to occur beyond those impacts addressed in the appropriate environmental documents for those projects.

4.1 NO-PROJECT ALTERNATIVE

The No-Project Alternative includes the implementation of programmed improvements to highways and existing, conventional rail corridors by the year 2020. Environmental studies are being implemented independently for these improvements, and so they do not constitute part of this Project. No additional impacts to paleontologic resources are expected to occur beyond those impacts addressed in the appropriate environmental documents for those projects.

4.2 MODAL ALTERNATIVE

4.2.1 Segment 1

This portion of the proposed project APE crosses the following sedimentary units and geologic formations: windblown sand; wash deposits; Quaternary older wash deposits; Quaternary gravel; Quaternary younger alluvium; Quaternary younger fan deposits; Quaternary alluvium of indeterminate (Pleistocene or Holocene) age; Pleistocene older alluvium (including Pleistocene terrace deposits and Pleistocene older fan deposits); the Fernando Formation; the Puente Formation; the Topanga Formation; the Glendora Volcanics; and quartz diatomite of Cretaceous age. Of these units, the following have high potential to contain significant nonrenewable paleontologic resources: Pleistocene older alluvium (including Pleistocene terrace deposits and Pleistocene older fan deposits); the Fernando Formation; the Puente Formation; and the Topanga Formation. These units are assigned high paleontologic sensitivity, both where exposed (but previously undisturbed) at the surface and at depth.

Paleontologic resource localities LACM 1027, 1147, 3363, 6166 – 6167, 6171 – 6173, 6951, 7007, and 7190, as well as SBCM 5.1.8 and 5.1.11 are situated within 1¼ mile or less of the proposed project APE. Localities LACM 1027 and 7007 yielded fossil remains of *Xyne grex* from exposures of the Puente Formation. Locality LACM 1147, also recorded from the Puente Formation, yielded a specimen of *Cormohipparion occidentale* (Stock, 1928). Localities LACM 1027, 3363, 6166 – 6167, 6171 – 6173, 6951, 7007, and 7190 yielded fossils of marine vertebrates from the Puente Formation. Locality LACM 3363 yielded fossil remains of extinct horse (*Equus*) from the Fernando Formation. Localities SBCM 5.1.8 and 5.1.11 yielded fossil remains of mammoth (*Mammuthus*) and sabre-toothed cat (*Smilodon*), respectively, from Pleistocene older alluvium.

4.2.2 Segment 2

This portion of the proposed project APE crosses the following sedimentary units and geologic formations: recent wash sediments; recent alluvium; Quaternary younger alluvium; Quaternary younger fan deposits; Pleistocene older alluvium (including Pleistocene very old fan gravels, Pleistocene older fans, and undifferentiated Pleistocene older alluvium); the Pauba Formation; the unnamed sandstone and conglomerate formation of Kennedy (1977); the Puente Formation; the Silverado Formation; the Southern California Batholith; and the metamorphic basement complex (including the Santiago Peak Volcanics and the Bedford Canyon Formation). Surface exposures of the undifferentiated Sespe and Vaqueros Formations are also know from along this portion of the APE, and may very likely occur in the subsurface within the APE. Of these units, the following have high potential to contain significant nonrenewable paleontologic resources: Pleistocene older alluvium; the Pauba Formation; the unnamed sandstone and conglomerate formation of Kennedy (1977); the Puente Formation; the undifferentiated Sespe and Vaqueros Formations; and the Silverado Formation. These units are all assigned high paleontologic sensitivity, both where exposed (but previously undisturbed) at the surface and at depth.

Paleontologic resource localities SBCM 5.5.2 – 5.5.3, 5.5.22 – 5.5.25, 5.6.2, 5.6.4 – 5.6.46, 5.6.65, 5.6.71 – 5.6.89, 5.6.92 – 5.6.93, 5.6.101 – 5.6.103, 5.6.106, 5.6.132 – 5.6.152, 5.6.154 – 5.6.160, 5.6.163 – 5.6.187, 5.6.191 – 5.6.192, 5.6.194 – 5.6.197, 5.6.203 – 5.6.208, 5.6.214, 5.6.225 – 5.6.227, 5.6.259 – 5.6.260, 5.6.289 – 5.6.340, 5.6.342, 5.6.349, 5.6.362 – 5.6.367, 5.6.379 – 5.6.388, and 5.6.394 – 5.6.399 are located within the APE along this portion of the Highway Modal Alternative. Localities 5.5.2 and 5.5.3 yielded fossil remains of plants and pelecypods from the Silverado Formation. Paleontologic resource localities SBCM 5.5.22 through 5.5.25 are located within ½ mile of the APE along this portion of the Highway Modal Alternative; these localities yielded fossil remains of carbonized plants. Paleontologic resource localities SBCM 5.6.2, 5.6.4 – 5.6.46, 5.6.65, 5.6.71 – 5.6.89, 5.6.92 – 5.6.93, 5.6.101 – 5.6.103, 5.6.106, 5.6.132 – 5.6.152, 5.6.154 – 5.6.160, 5.6.163 – 5.6.169 – 5.6.187, 5.6.191 – 5.6.192, 5.6.194 – 5.6.197, 5.6.203 – 5.6.208, 5.6.214, 5.6.225 – 5.6.227, 5.6.259 – 5.6.260, 5.6.289 – 5.6.340, 5.6.342, 5.6.349, 5.6.362 – 5.6.367, 5.6.379 – 5.6.388, and 5.6.394 – 5.6.399 are all located within ¼ to 1 mile from the APE. Vertebrate fossils recovered from these localities include mammoths, mastodons, ground sloths, dire wolves, short-faced bears, sabre-toothed cats, tapirs, horses, camels and llamas, along with abundant (and in many cases temporally-diagnostic) small vertebrates and invertebrates (Reynolds and others, 1991; Scott, 1992, 1998, 1999; Scott and Cox, 1993; Pajak, Scott and Bell, 1996). Locality SBCM 5.6.399 also yielded remains of the extinct giant teratorn *Aiolornis incredibilis*, the largest flying bird known from North America (Campbell, Scott and Springer, 1999).

4.2.3 Segment 3

This portion of the proposed project APE crosses the following sedimentary units and geologic formations: artificial fill; recent wash sediments; recent alluvium; Quaternary younger alluvium; Quaternary younger fan deposits; Pleistocene older alluvium (including Pleistocene very old fan gravels, Pleistocene older fans, and undifferentiated Pleistocene older alluvium); the Lindavista Formation; the Mission Valley Formation; the Stadium Conglomerate; the Friars Formation; the Southern California Batholith; and the metamorphic basement complex (including the Santiago Peak Volcanics and the Bedford Canyon Formation). Of these units, the following have high potential to contain significant nonrenewable paleontologic resources: Pleistocene older alluvium; the Lindavista Formation; the Mission Valley Formation; the Stadium Conglomerate; and the Friars Formation. These units are all assigned high paleontologic sensitivity, both where exposed (but previously undisturbed) at the surface and at depth.

Paleontologic resource localities SDNHM 3639, 5138 and 5139 are located within the APE along this portion of the Highway Modal Alternative. These localities yielded artiodactyl, perissodactyl and possible tapir fossils from exposures of the Friars Formation.

4.3 High Speed Train Corridors

4.3.1 Segment 1-A-1

This portion of the proposed project APE crosses the following sedimentary units and geologic formations: Quaternary younger alluvium; Pleistocene older alluvium; Fernando Formation; Puente Formation; and the Glendora Volcanics. Of these units, the Pleistocene older alluvium and the rocks of the Fernando Formation and the Puente Formation have potential to contain significant nonrenewable paleontologic resources. These units are assigned high paleontologic sensitivity, both where exposed (but previously undisturbed) at the surface and at depth.

Paleontologic resource locality LACM 3882, located in the Lincoln Heights area near the proposed project APE, yielded the holotype (= name-bearing specimen of a species new to science) of the fossil baleen whale *Mixocetus elysius* (Kellogg, 1934) from the Puente Formation. Localities LACM 1027 and 7007, also located near the proposed project APE near the terminus of Interstate 710, yielded fossil remains of *Xyne grex* from exposures of the Puente Formation. Resource locality LACM 6170, located between the proposed project APE and San Jose Creek in the City of Industry, produced fossil specimens of *Decapterus* (scad) and *Thyrsocles kriegeri* (oilfish) from the Puente Formation. Locality LACM 7153, also near the proposed APE in Pomona, yielded the holotype specimen of *Syngnathus emeritus* (Fritzsche, 1980).

4.3.2 Segment 1-A-2

This portion of the proposed project APE crosses the following sedimentary units and geologic formations: recent windblown sand; recent wash sediments; Quaternary younger fan deposits; and Pleistocene older alluvium. Of these units, the Pleistocene older alluvium has potential to contain significant nonrenewable paleontologic resources. This unit is assigned high paleontologic sensitivity, both where exposed (but previously undisturbed) at the surface and at depth. Paleontologic resource localities LACM 6350 – 6361, located immediately south of the proposed project APE west of Beech Avenue, collective produced a fossil fauna from the Fernando Formation that included great white shark (*Carcharodon carcharias*), herring (*Ganolytes*), hake (*Merluccius*), lanternfish (*Diaphus* and *Lampanyctus*), mackerel (Scombridae), swordfish (*Coelorhynchus scaphopsis*), flounder (Pleuronectidae) and whale (Cetacea).

4.3.3 Segment 1-A-3

This portion of the proposed project APE crosses the following sedimentary units and geologic formations: recent windblown sand; recent wash sediments; older Holocene wash sediments; Quaternary younger fan deposits; and Pleistocene older alluvium. Of these units, the Pleistocene older alluvium has potential to contain significant nonrenewable paleontologic resources. This unit is assigned high paleontologic sensitivity, both where exposed (but previously undisturbed) at the surface and at depth.

4.3.4 Segment 1-A-4

This portion of the proposed project APE crosses the following sedimentary units and geologic formations: Pleistocene older alluvium and Mesozoic granitic rock. Of these units, the Pleistocene older alluvium has potential to contain significant nonrenewable paleontologic resources. This unit is assigned high paleontologic sensitivity, both where exposed (but previously undisturbed) at the surface and at depth.

4.3.5 Segment 1-B-1

This portion of the proposed project APE crosses the following sedimentary units and geologic formations: Quaternary younger alluvium; Pleistocene older alluvium; and Puente Formation. Of these units, the Pleistocene older alluvium and the Puente Formation have potential to contain significant nonrenewable paleontologic resources. These units are assigned high paleontologic sensitivity, both where exposed (but previously undisturbed) at the surface and at depth. Paleontologic resource locality SBCM 1.116.10 is located ~1 mile southeast of the APE near its closest approach to Old Brea Canyon Road; this locality yielded fossil remains of extinct whale (Cetacea). Paleontologic resource localities SBCM 1.116.275 – 1.116.276 are located approximately two (2) miles south of the APE where it intersects Segment 1-A-1; these localities yielded fossil remains of small terrestrial vertebrates from Pleistocene older alluvium.

4.3.6 Segment 1-C-1

This portion of the proposed project APE crosses the following sedimentary units and geologic formations: windblown sand; recent wash sediments; Quaternary younger fan deposits; and Pleistocene older alluvium, including Pleistocene older fan deposits. Of these units, the Pleistocene older alluvium (including Pleistocene older fan deposits) has potential to contain significant nonrenewable paleontologic resources. These Pleistocene sediments are therefore assigned high paleontologic sensitivity, both where exposed (but previously undisturbed) at the surface and at depth. Paleontologic resource locality SBCM 1.102.2 is located immediately west of the APE south of the second crossing of Lytle Creek; this locality has yielded fossil wood portions from depths of more than 430 feet below the existing ground surface. However, Pleistocene older alluvium may be closer to the ground surface than these depths indicate.

4.3.7 Segment 2-A-1

This portion of the proposed project APE crosses the following sedimentary units and geologic formations: recent wash sediments; Quaternary younger alluvium; Quaternary alluvium of indeterminate (Holocene or Pleistocene) age; Pleistocene older alluvium; the Pauba Formation; the unnamed sandstone and conglomerate formation of Kennedy (1977); Jurassic metasedimentary rock; and Mesozoic granitic rock. Of these units, the Pleistocene older alluvium (including Pleistocene older fan deposits), the Pauba Formation, and the unnamed sandstone of Kennedy (1977) all have potential to contain significant nonrenewable paleontologic resources.

These sediments are therefore assigned high paleontologic sensitivity, both where exposed (but previously undisturbed) at the surface and at depth.

Paleontologic resource localities SBCM 5.6.4 – 5.6.60, 5.6.65, SBCM 5.6.94 – 5.6.99, 5.6.101 – 5.6.103, 5.6.106, 5.6.132 – 5.6.140, 5.6.163 – 5.6.167, 5.6.170, 5.6.172 – 5.6.178, 5.6.180, 5.6.182 – 5.6.186, 5.6.214, 5.6.225 – 5.6.227, 5.6.229 – 5.6.246, 5.6.250 – 5.6.260, 5.6.289 – 5.6.295, 5.6.337 – 5.6.340, 5.6.342, 5.6.378, 5.6.400 – 5.6.425, 5.6.427, 5.6.539, 5.6.544, and 5.6.550 are all located within ¼ to 1 mile from the APE in the Murrieta and Temecula regions. Vertebrate fossils recovered from the Pauba Formation and the underlying unnamed sandstone formation of Kennedy (1977) at these localities include mammoths, mastodons, ground sloths, dire wolves, short-faced bears, sabre-toothed cats, tapirs, horses, camels and llamas, along with abundant (and in many cases temporally-diagnostic) small vertebrates and invertebrates (Reynolds and others, 1991; Scott, 1992, 1998, 1999; Scott and Cox, 1993; Pajak, Scott and Bell, 1996).

4.3.8 Segment 2-A-2

This portion of the proposed project APE crosses the following sedimentary units and geologic formations: Quaternary alluvium of indeterminate (Holocene or Pleistocene) age; granitic rock of the Southern California Batholith; and basement metamorphic rocks including the Santiago Peak Volcanics and the Bedford Canyon Formation. Of these units, the Quaternary alluvium has undetermined (potentially high) sensitivity.

4.3.9 Segment 2-A-3

This portion of the proposed project APE crosses the following sedimentary units and geologic formations: Quaternary alluvium of indeterminate (Holocene or Pleistocene) age; the Lindavista Formation; the Friars Formation; Jurassic metasedimentary rock; and Mesozoic granitic rock. Of these units, the Quaternary alluvium has undetermined (potentially high) sensitivity, while the Lindavista Formation and the Friars Formation have high potential to contain significant nonrenewable paleontologic resources. These latter two rock units are therefore assigned high paleontologic sensitivity, both where exposed (but previously undisturbed) at the surface and at depth.

4.3.10 Segment 2-B-1

This portion of the proposed project APE crosses the following sedimentary units and geologic formations: Quaternary alluvium of indeterminate (Holocene or Pleistocene) age; granitic rock of the Southern California Batholith; and basement metamorphic rocks including the Santiago Peak Volcanics and the Bedford Canyon Formation. Of these units, the Quaternary alluvium has undetermined (potentially high) sensitivity.

4.3.11 Segment 3-A-1

This portion of the proposed project APE crosses the following sedimentary units and geologic formations: Quaternary alluvium of indeterminate (Holocene or Pleistocene) age; the Lindavista Formation; the Stadium Conglomerate; and the Friars Formation. Of these units, the Quaternary alluvium has undetermined sensitivity, while the Lindavista Formation, the Stadium Conglomerate, and the Friars Formation all have high paleontologic sensitivity. These rock units are therefore assigned high paleontologic sensitivity, both where exposed (but previously undisturbed) at the surface and at depth.

Paleontologic resource localities SDNHM 3343, 3488, 3730, 3784 and 3851 are all located within ¼ to ½ mile from the APE along Segment 3-A-1. Fossils recovered from these localities were derived from exposures of the Friars Formation; taxa recovered include molluscs, sharks and small to medium-sized terrestrial mammals such as *Peratherium*, *Sciuravis*, *Pseudostomus*, *Pareumys*, *Metanoiamys*, *Amynodon*, *?Metarhinus*, *Merycobunodon*, *Achaenodon*, cf. *Antiacodon*, *Protoreodon*, and *Leptoreodon*. Partial skulls of *Sciuravis* and *Pareumys* from SDNHM 3784 are particularly noteworthy.

4.3.12 Segment 3-B-1

This portion of the proposed project APE crosses the following sedimentary units and geologic formations: artificial fill; Quaternary alluvium of indeterminate (Holocene or Pleistocene) age; Quaternary river terrace deposits; the Bay Point Formation; the Lindavista Formation; the Friars Formation; the Scripps Formation; and the Ardath Formation. Of these units, the Quaternary alluvium has undetermined sensitivity, while the remaining rock units all have high paleontologic sensitivity. These rock units are therefore assigned high paleontologic sensitivity, both where exposed (but previously undisturbed) at the surface and at depth.

Paleontologic resource locality SDNHM 3291 is located within ¼ mile from the APE along Segment 3-B-1. The fossil recovered from rocks of the Scripps Formation at this locality was a piece of petrified wood.

4.3.13 Segment 3-B-2

This portion of the proposed project APE crosses the following sedimentary units and geologic formations: artificial fill; Quaternary alluvium of indeterminate (Holocene or Pleistocene) age; the Bay Point Formation; the Stadium Conglomerate; the Scripps Formation; and the Ardath Formation. Of these units, the Quaternary alluvium has undetermined sensitivity, while the remaining natural rock units (exclusive of artificial fill) all have high paleontologic sensitivity. These rock units are therefore assigned high paleontologic sensitivity, both where exposed (but previously undisturbed) at the surface and at depth.

Paleontologic resource localities SDNHM 16, 64, 138, 146, 3204, 3236, 3277, 3287, 3412, 3675, 3718 – 3722, 3761, 4059, 4663, 5013, 5127 – 5128, 5138 – 5139, 5155, 5166, 5179, and 5184 are all located within ¼ to ½ mile from the APE along Segment 3-B-1. Fossils recovered from these localities were derived from exposures of the Bay Point Formation, the Scripps Formation, and the Ardath Shale (except for localities SDNHM 3204 and 3287, which were recovered from exposures of the San Diego Formation). Taxa recovered from the Bay Point Formation along this segment include abundant marine molluscs, some fossils of sharks, rays, and bony fish, as well as teeth of extinct mammoths (*Mammuthus*). Fossils identified from the Scripps Formation along segment 3-B-2 include plant portions as well as casts and molds of molluscs. The Ardath Shale yielded leached molluscan endocasts and external molds, a thick oyster "shellhash" (at SDNHM 3722), and a shark tooth from near segment 3-B-2.

4.3.14 Segment 3-C-1

This portion of the proposed project APE crosses the following sedimentary units and geologic formations: Quaternary alluvium of indeterminate (Holocene or Pleistocene) age; the Lindavista Formation; and the Friars Formation. Of these units, the Quaternary alluvium has undetermined sensitivity, while the remaining rock units all have high paleontologic sensitivity. These rock units are therefore assigned high paleontologic sensitivity, both where exposed (but previously undisturbed) at the surface and at depth.

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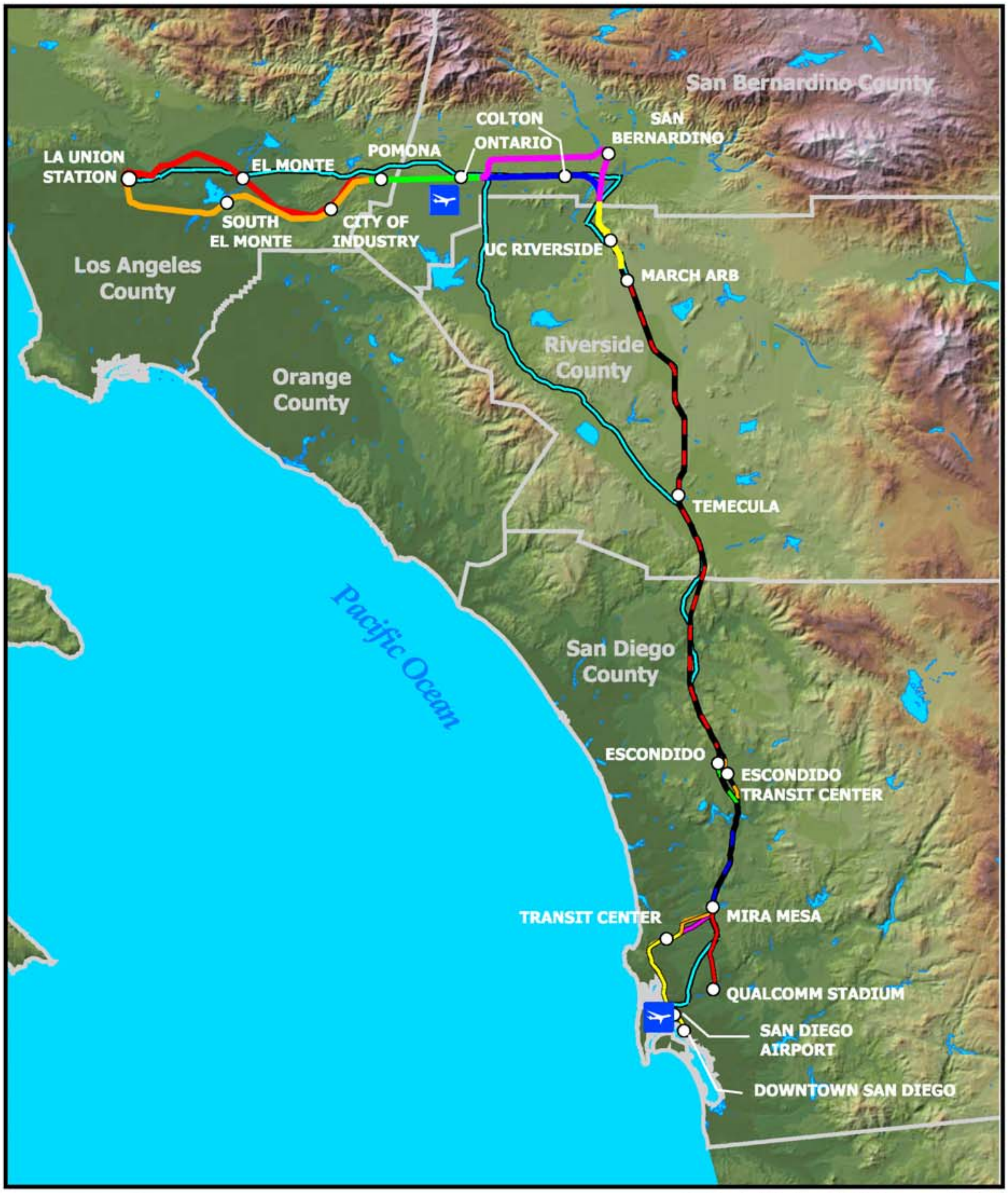
Appendix A



Source: CH2M HILL, 2001

California High-Speed Train Program EIR/EIS

0 15 Miles

10 0 10 Kilometers

Legend

Segment 1 Subsegments		Segment 2 Subsegments		Segment 3 Subsegments	
	1A1		2A1		3A1
	1A2		2A2		3B1
	1A3		2A3		3B2
	1A4		2B1		3C1
	1B1		Proposed Station		Highway Modal Alternative
	1C1		Airport Modal Alternative		

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Figure A-1 Modal and HST Alignments Los Angeles to San Diego via Inland Empire